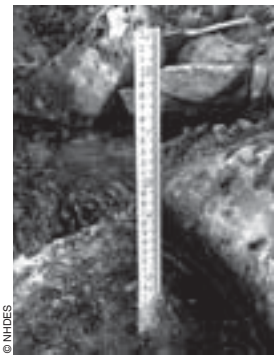
project WEB

Spring 2008

Connecting Projects WILD, WET and Learning Tree in New Hampshire

Math Naturally: Integrating Math and Science

During every career day event that I attend, I give the students a list of classes they will need to take to receive a science degree. Inevitably, when they see various forms of math listed, a groan ripples through the class. The students do not realize that math skills are necessary to be a good scientist. Because science and math are taught as separate classes, many students – and adults, for that matter – view them as two disparate fields of study. This idea could not be more false.



© NHDES

Gages indicate water levels

Science relies on mathematics for its laws and formulas. Some of the most well-known laws are the laws of motion and gravitation. Where would Sir Isaac Newton have come up with his second law of motion (force equals mass times acceleration), if he did not have a strong foundation in mathematics?

Many scientists and mathematicians throughout history have recognized the connections between math and science. Johann Carl Friedrich Gauss, a mathematician and scientist in the early 19th century, called mathematics "the Queen of the Sciences." Charles Darwin stated, "Every new body of discovery is mathematical in form, because there is no other guidance we can have."

It is not a new idea to teach science and math as a combined unit. Because the two subjects share many concepts – taking measurements, using formulas, using statistics – this should be a fairly natural crossover. Students must experiment in both subjects to reach conclusions and must use their intuition to get them through the processes.

Why will combining aspects of these two subjects benefit your students, and how can you do this easily while still maintaining a connection to the state frameworks? These questions and more will be answered in this issue. Articles were contributed by working scientists to show how science and math are used in the "real world" and by educators to provide you with insight on linking math and science in your classroom. WEB

IN THIS ISSUE

"What science can there be, more noble, more excellent, more useful for men, more admirably high and demonstrative, than this of mathematics?"
~Benjamin Franklin

From SMART to Finish:

Inquiry-based high school science that's out of this world

The kid with scraggly, shoulder-length hair is wearing a black sweatshirt embossed with a white, bat-winged skull and crossbones and the words "Avenged Sevenfold" – his favorite heavy metal band. He peels off the garment to reveal a black T-shirt advertising the Scandinavian Goth metal/alternative rock band "His Infernal Majesty."

Meet Stephen Wright-Eaton, high school senior, avid alternative music fan, devoted paintball player and, coincidentally, an expert on the spectral features of mineral-based polyhydrated sulfates on the planet Mars.

At last December's 14,000-strong American Geophysical Union (AGU) meeting held in San Francisco, Wright-Eaton, along with high school junior Matt Vaillancourt, presented results of the Mars spectral analysis work they've been doing at UNH with professors Barry Rock and Chuck Smith.

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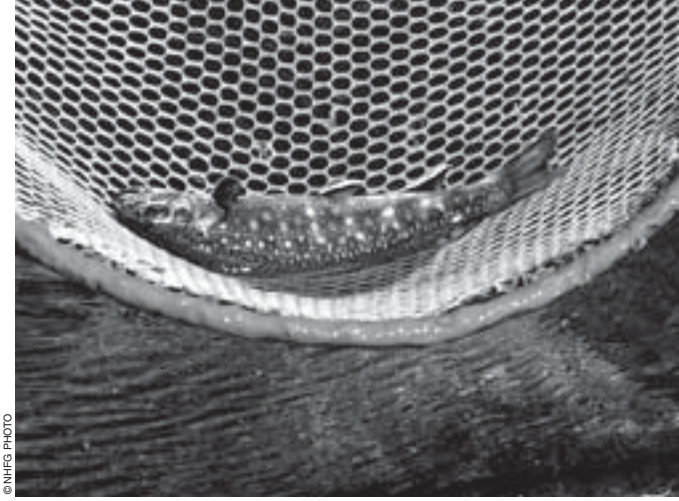
Fishing Mathematically

By Andrew Schafermeyer, N.H. Fish and Game Fisheries Biologist



© NHFG PHOTO

Mathematics has long been considered an important tool in fisheries management. Not only is it used to estimate numbers, but also to determine the health of a population. Being able to estimate and make extrapolations about populations using math saves valuable time and greatly reduces the stress on the fish.

Imagine trying to calculate the number of salmon fry in a one-gallon pail. The actual number of fish may be in the thousands and physically separating and counting them would border on the impossible. Fortunately, biologists and fish culturists have created some mathematical shortcuts to make the process faster and easier. Taking a few small samples of known numbers and weighing or measuring them allows for a pretty accurate sample average. Once the sample average is known for a specific group of fish, one can expand the calculation to uncover an actual number of fish without handling every individual.

You can imagine the advantages to this method of enumeration. As fisheries professionals pull a net in to estimate fish populations in a certain waterbody, some species sampled can reach very high numbers. In order to process the sample in a timely and statistically valid manner, a sample-based average is applied. This type of calculation is also used when hatchery personnel load trucks with hundreds of trout and salmon to stock rivers and ponds. Counting every fish as it is loaded would take hours and place unnecessary handling and stress on the fish. Instead, full nets are weighed and loaded quickly and efficiently using the process of averaging and estimating.

Another important use for mathematical formulas in fisheries management is using length and weight measurements in calculating overall fish health. The term "relative weight" refers to the length-weight relationship and assigns an actual value showing the healthiest shape of a fish. A brown trout of a given length, for example, should have a weight that represents a healthy metabolism. Low relative weight values are indicative of thin or "racy" fish but may also be found in those fish that take on a stubby, football shape. The formulas are different for every species of fish and provide managers with a quick guide as to the overall health of a population.

WEB

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The two high schoolers began the work last summer as Project SMART students. With encouragement from Rock and Smith, they continued their project after returning to Oyster River High School in Durham (Wright-Eaton) and Marshwood High School in South Berwick, Maine (Vaillancourt).

SMART, for Science and Mathematics Achievement through Research Training, is a summer institute that pairs talented high school students with UNH researchers on specific scientific projects. Students focus their research in one of three modules: Bio- and Nanotechnology; Marine and Environmental Science; and Space Science (www.smart.unh.edu).

Smith is a solar wind specialist and coordinates the Space Science module. Rock is faculty for the Environmental Science module. The professors took an interdisciplinary approach to create the Mars Remote Sensing project.

Rock, a Complex Systems Research Center botanist who is an expert in hyperspectral remote-sensing techniques, helped the students apply the tools he uses to study forests to their keen interest in analyzing surface features of Mars. Wright-Eaton and Vaillancourt used spectral data derived by an instrument aboard the European Space Agency's (ESA) Mars Express orbiter, called OMEGA, to study the Meridiani Planum region.

© BARRY ROCK PHOTO, UNH INSTITUTE FOR THE STUDY OF EARTH, OCEANS AND SPACE

High school students Stephen Wright-Eaton (left) and Matt Vaillancourt (far right) discuss their Mars findings at the AGU meeting in San Francisco.

The project culminated in the weeklong trip to San Francisco (made possible with funding support from the New Hampshire Space Grant Consortium) to present their research to, in some cases, renowned scientists doing the very same kind of analysis using data being gathered on or above Mars by surface rovers and satellites!

The students, who Rock says were more than slightly nervous, figured their work would pale to that of the assembled horde of "real scientists," but Rock and Smith knew better. "The work they had done was very substantive and scientifically valid and these are high school students," says Rock. And so, he adds, it made a lot of sense to find a way to get "the boys" out to AGU to showcase their accomplishments and tout the merits of Project SMART.

At AGU, the boys turned more than a few heads, and they were taken aback when a team of French OMEGA scientists showed up in front of their poster to ponder the science and ask questions. "The OMEGA team was amazed that high school students were able to do this and were extremely pleased that ESA's decision to make the Mars data available to

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Spotlight on...

HHP Inc. Sawmill

By Peggy Herbert, Henniker Community School (retired)

Five years ago, HHP Inc., a local sawmill in Henniker, N.H., began to host the Henniker fourth graders for a sawmill tour. This trip offers the students a chance to see technology in action as well as job specialization, ecological use of resources and how a resource is changed from a raw material into a processed form that can then be used for many different things.

When the class arrives, they are met by President Ross D'Elia, and Procurement Manager Don Windsor, along with NHPLT staff and state forestry professionals. A "stations" format is used for the field trip and is the most effective way of keeping students' attention while still allowing for some hands-on activities. After a general welcome and introduction, the groups are given helmets and earplugs and are off.

At one station, students watch as the trucks come and get weighed on a special scale. Here they also learn what the different types of wood chips created at the mill are used for. Another station is the mill itself, where students watch logs get debarked, sawed into boards, graded and finally end up in the sorting bins. Another station is out at the gigantic log piles, where students make bark rubbings of different New Hampshire trees; use a scaler to figure out the value and volume of these trees; and learn how to plant the white pine seedling that they will be taking home at the end of the day. The final station is the pallet shop where, after watching how machines make pallets, students work together to make a handmade pallet to take back to their classroom. At every station, HHP Inc. uses their staff to help the students understand what they are seeing and learning.

This trip is a good way to cover a number of science and social studies standards, as well as to reinforce many math concepts. Data can be collected at the mill and then used to problem solve in math back in the classroom. Here are some examples:

"This trip is a good way… to reinforce many math concepts."

1. **How much does the class weigh?** Weigh the bus empty and then weigh it full of students and subtract. Then use your class weight to find out what you'd be worth as hemlock chips or white pine chips.

© NH PROJECT LEARNING TREE

Students measure and construct a pallet to take back to class during a sawmill field trip.

2. **How long does it take?** Use a stopwatch and follow a board from start to finish. The board could be visibly marked and followed until it ended up in a bin. Older students could then figure out how many boards come through in a minute and from that, how many boards are sawn in an hour or a day and relate that to how many board feet it takes to build an average house.

3. **How many board feet can you get from a log?** Using Biltmore sticks, figure out how many board feet are in different logs of different types of trees.

4. **How big is a tree's trunk?** Radius and diameter – using measuring sticks, figure out the radius and diameter of logs. More advanced groups could then figure out a rough circumference. Younger children could use a flexible tape measure and measure the circumference.

5. **Estimating** – Most of these activities could be estimated before they are actually figured out.

HHP Inc. is just one of the processing mills around the state that accepts school groups. For more information about mills that support teachers in N.H., please contact NHPLT at info@nhplt.org *or (603) 226-0160.* WEB

WEB RESOURCES*

- Activities Integrating Mathematics and Science: ***www.aims.edu***
- Eisenhower National Clearinghouse: ***www.goenc.com***
  Subscription required to view curriculum resources and professional development materials.
- Educational REALMS (Resources Educating Active Learners in Math and Science): ***www.stemworks.org/lessons.html***
- Joan and James Leitzel Center for Mathematics, Science and Engineering Education at UNH: ***http://leitzelcenter.unh.edu***

** Some free, some require a fee.*

Streams as Teachers of Math and Science

By Wayne Ives, NHDES Hydrogeologist

Scientists are frequently depicted wearing lab coats and working with computers. Computers are great tools for working with numbers and figuring out problems, but natural scientists work with bugs or rocks, trees or streams. So how do these scientists get numbers from a rock or a stream? In hydrology, the study of water, the numbers often come from scientists wearing boots and standing in water to collect measurements that describe stream flow with numbers.

Streams represent a combination of geology, climate and land use, so stream flow is an important indicator of environmental conditions. The amount of stream flow can be an important indicator of droughts and floods, or whether fish species can survive. Streams are usually measured in cubic meters per second or cubic feet per second (cfs). A basketball is about the size of one cubic foot. One cfs is like a basketball rolling past you every second. It would be hard to count a lot of basketballs worth of water going by, so scientists make several measurements to estimate the amount of water. First, they measure the stream's height and width, which shows the number of "basketballs" going by (or the cross-sectional area in square feet). Then, they measure the stream's speed to see how fast those basketballs are going by (or the velocity in feet per second).

Measuring the cross-sectional area has to be done in sections, since a stream bottom is rarely flat and the stream's flow is faster in the middle. Measurements are made in narrow sections representing flow from the water surface to the stream bed. Each section is measured for depth, width and velocity. Multiplying depth X width X average velocity gives values in cfs for a series of rectangles starting at the slower, shallow margins and crossing the deeper, faster middle, back to the opposite margin. By adding the flow through each rectangular section, the stream flow for that day is calculated.

Just as a stream's depth changes from bank to bank, a stream's velocity changes from bank to bank and from top to bottom. You could measure a lot of velocities in each rectangle to determine the average velocity for that rectangle. However, scientists have determined from making many measurements that stream flow is faster near the top and slower near the bottom and about equal to the average at 60% of the rectangle's depth. By measuring the depth of the rectangle and multiplying by 0.60, you can find the point to measure the average flow velocity for that rectangle.

These measurements show you the stream flow on that day, but if you come back later, the flow will have gone up or down and you will have to measure again. If you come back even later, the flow will have changed once more. However, if you make stream flow measurements over a range of high and low flows and measure how high the water is at some reference point, you can tell the stream flow without making any more measurements by using a rating curve. A rating curve shows the height of the water compared to the reference point. Past measurements of stream flow can be used to create a chart that tells you what the flow is when the stream is at that height. If the stream is at a height that you haven't measured before, you can interpolate, or connect the dots between a higher and a lower measurement, to find the flow for that stream height.

Computers can give us answers to complex problems, but they only work with the numbers we provide. Measure carefully!

© NH PROJECT LEARNING TREE

Scientists measure river flow to determine the relationship between stream flow and river height.

Experiment!

Are you looking for an easy experiment to show your students the connection between math and science? Students can measure stream flow by following these instructions.

Materials: Tape measure, watch with a second hand or stopwatch, an orange or a stick, and a calculator (If you use an orange, make sure you make every effort to remove it from the water when you are done.)

Procedure:

1. Measure a 100-foot distance on the bank along the straightest stretch of stream you can find with few obstructions such as large rocks.
2. Place one student upstream with the orange and a second student downstream with the stopwatch.
3. Have the student throw the orange into the water and indicate to the student with the watch once the orange hits the water. The clock starts now.
4. The clock stops when the orange reaches downstream student.
5. Record the time.
6. Repeat the experiment a few times in this location so an average can be recorded.
7. To calculate the flow in feet per second, use the distance (100 feet) divided by time.
8. Repeat the experiment on another stretch of the stream or at a different stream to show the difference in stream flow.

For more advanced students, follow the instructions from the website for A Citizen's Guide to Understanding and Monitoring Lakes and Streams from the Washington State Department of Ecology: ***www.ecy.wa.gov/programs/wq/plants/management/joysmanual/5float.html***.

Math Applications in Forestry

By Rod Wilson, US Forest Service

Forestry experts, called foresters, are problem solvers. They balance the management of the forest to produce products people use, with the need to conserve forest areas for wildlife and recreational use. Math is one of the many things that a forester uses to maintain this balance. Foresters use percents, diameters, tallies, area, scales and other forms of algebra and geometry every day.

Many math applications are done regularly in the field, and some of the common applications have been put into tables stored in data recorders for field use by foresters. Some forestry math applications are:

1. **Map and Aerial Photos:** Maps and aerial photos are used to identify current forest composition and landscape features. Maps and aerial photos are prepared using a specified scale. If one knows the scale, then distances on the map can be calculated. For example a 1:12,000 map is 1 inch = 12,000 inches (or 1,000 feet) on the ground. Maps are also used when estimating how fast a forest will grow, planning when to harvest the trees, and marking certain areas for environmental protection.

2. **Counting:** The most basic math used in forestry is counting. Field personnel count many things. A simple example is counting the rings on a tree that has been bored, or counting the whorls on a pine tree to determine its age. Another is counting trees or shrubs in a specified area, or counting certain species of trees, or certain numbers of wildlife or fish during field surveys.

3. **Percents:** Percents are used in many ways. In reporting or in analysis, the percent of an area to be treated can be figured by dividing the treated area by the total area. Percents are also used in estimating the value of timber where wood defects are present. When estimating volumes, individual tree value is reduced by an estimated percent of defect.

4. **Computing Area:** Many forestry applications include the need to know the area expressed in acres. The area is obtained now using GPS technology that does what foresters formerly did with more primitive field tools, a compass and "chain" (a metal measuring tape). Pacing, a measured distance using number of paces equaling a certain number of feet, was used until more accurate tools were developed. A simpler example of area measurement used by foresters is determining the radius needed for a round plot of a specific size. The formula used is (Pi R squared).

5. **Volume:** Foresters need to know the height and diameter of the tree to understand the volume of wood in the tree. Trigonometry is used for estimating tree heights. Here, the angle(s) of sight to the base and the top of a tree from a specific predetermined distance (33 feet or 66 feet) is used to calculate the tree height. The angles are determined using clinometers, an ocular instrument designed for this purpose. The distance is measured using a "hip chain." This is the volume of a tapering cylinder. The volume varies with the degree of taper. Foresters use tapes to measure the diameter of a tree. They always measure the diameter at 4.5 feet above the ground. This measurement is called "Diameter at Breast Height."

© USDAFS PHOTO

A forester measures the diameter of a tree at breast height to estimate the volume of wood in a tree.

6. **Statistics:** Widely used in forestry applications, statistics are the basis for setting up a sampling scheme for collecting field data on a specific section of ground. The use of statistics is very important in forestry to estimate the value of a large population (whether wood volumes and value or other populations) without having to sample every character in the population. This saves money and time in estimating the total population.

Foresters use math skills daily to manage and conserve our forest resources. WEB

Activities Related to Articles in This Issue

Project WET suggests:

In *Aqua Bodies*, students learn about the proportion of water in their bodies. Learning how much their bodies are made up of water encourages students to appreciate life's dependence on water.

Students compare the quantities of water used by a contemporary family to one in the late 1800s in *Easy Street*. Students also investigate changes in water use habits and identify water conservation strategies.

Using observations and simple calculations in *Money Down the Drain*, students learn that a dripping faucet wastes a valuable resource. They will analyze the financial benefits of fixing leaking faucets.

Project Learning Tree suggests:

In *How Big Is Your Tree?* students measure trees in different ways and become familiar with the tree's scale and structure.

In *Every Drop Counts*, students monitor how much water they use in a day and why it is important to conserve it.

In *400-Acre Wood*, students experience the analysis and decision-making involved in managing forestland.

Project WILD suggests:

Elementary school students tally the number of animals seen on an "indoor" nature walk through two different habitats, then graph and compare the results in Graphananimal.

In *I'm Thirsty*, middle school students use data provided to perform mathematical calculations and to make inferences.

Using both linear and exponential population growth data provided in *Turkey Trouble*, high school students make computations and interpret results.

ANNOUNCEMENTS

Watershed Ecology: Summer Institute for Science Teachers and Community Leaders

Join us for the 2008 Watershed Ecology Institute at Bow High School on July 21-25 and July 28-August 1. This two-week undergraduate and graduate level course teaches educators and community leaders about everything aquatic in New Hampshire. Co-sponsored by N.H. Fish and Game and UNH, with instructors also from the Department of Environmental Services and the private sector. The course can be taken for 2 credits from the UNH Division of Continuing Education or as a non-credit course. For more information or a registration brochure, contact Judy Tumosa at 603-271-0456 or email *judy.l.tumosa@wildlife.nh.gov*.

American Groundwater Trust Teacher Institute

The American Groundwater Trust, a national nonprofit, is holding a teacher institute on July 21 and 22 in Lowell, MA. Information is available at *www.agwt.org*.

Lakes Appreciation Month Poster Contest for Grades 4 - 8

The North American Lake Management Society (NALMS) celebrates lakes during Lakes Appreciation Month every July. NALMS holds an annual poster contest for grades 4-8 to help promote the month. Submit your entries for the 2009 poster by October 31, 2008. The artist of the chosen poster design will receive prize money from NALMS, as will the artist's school. Contact Amy Smagula, the NALMS Education Co-Chair, for more information. She's right here in New Hampshire, so take advantage! Amy can be reached at (603) 271-2248 or *amy.smagula@des.nh.gov*.

A Forest For Every Classroom

The Forest for Every Classroom program will educate middle and high school teachers working in New Hampshire communities about forest stewardship issues and provide them with tools to develop curricula that meet the state's educational standards and can be implemented using their local landscape, resources and community for real world teaching. Graduate credits are available from PSU. This is a year-round professional development opportunity and begins August 6-8 and 12-13, at the Hubbard Brook Experimental Forest, Woodstock, NH. Other dates include October 10-11, 2008, and dates in February and May 2009 are TBA. For more information visit *www.nhplt.org* or contact Sara Head at (603) 226-0160.

Do you have an idea for a topic the WEB should address? If so, please contact Erin Hollingsworth at (603) 226-0160 or *info@nhplt.org.*

Environmental Pathways in the Classroom: PLT, WET and WILD

October 25, 2008, from 9 a.m.-5 p.m. at The Nature of Things Academy in Nashua. This workshop will introduce pre-service and in-service, formal and nonformal educators to the award-winning curriculum materials of Project Learning Tree (PLT), Project WET and Project WILD. These programs are designed to take forests, wildlife and water and make them real for preK-12 students. Activities are easily infused into everyday school subjects and busy classrooms. Workshop fees are $50 pre-service teachers and $75 in-service. For more information, contact Erin Hollingsworth at (603) 226-0160 or email *info@nhplt.org*.

PLT Resources Available Online

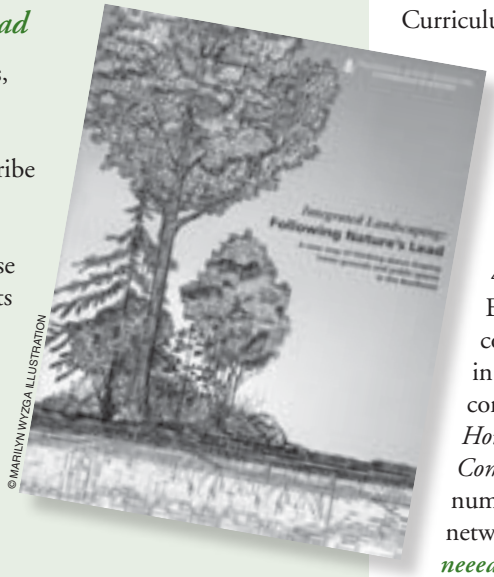
Are you looking for supplemental resources for activities in the PLT PreK-8 Guide? Printable student pages, technology connections, stories, charts, illustrations, and more are available at *www.plt.org*. Click on Curriculum, then PreK-8 Guide.

Children's Literature and PLT

Are you looking for children's literature to supplement a PLT activity? Would you like to find a PLT activity that correlates to a specific book you're reading? This is the website for you! Visit *www.plt.org*. Click on Curriculum, then PreK-8 Guide.

Integrated Landscaping: Following Nature's Lead

A new publication is here for New Hampshire gardeners, landscapers, businesses, schools and municipalities that want to create beautiful, functional landscapes based on natural ecosystems. While most landscape manuals describe a linear sequence of processes – design, plant selection, installation, and ongoing maintenance – *Integrated Landscaping* offers a holistic approach that addresses these processes simultaneously. This new way of thinking treats each site as a system of plant and animal communities, considering their interrelationships to each other and their environment. It provides alternatives to invasive species and recommendations for creating landscapes that benefit wildlife. The fully illustrated, 162-page *Integrated Landscaping* is available from UNH Cooperative Extension for $19.95 pus shipping. *http://extension.unh.edu/Pubs/Pubs.htm*



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2008 New England Environmental Educators Conference will be in New Hampshire!

Reserve the weekend of October 3-5, 2008 for the 42nd Annual New England Environmental Education Alliance conference at the Sargent Center in Peterborough, N.H. This year's conference is titled, *A Journey Home: Fostering Ecologically Centered Communities*. The event offers numerous EE-focused workshops and networking opportunities. Visit *www.neeea.org* this summer for information and registration materials.

ON THE

H.O.M.E. FRONT

The Measure of a Schoolyard Habitat:

Using Math Outdoors

by Marilyn Wyzga

"Inch by inch, row by row, gonna make this garden grow…" so sings David Mallett in his well-known 1970s tune about gardening. A schoolyard habitat is in many ways a garden, a growing place, rich with diverse plant species of different heights, textures and types, and a wide variety of wildlife species occupying many niches, meeting their habitat needs in places to feed, rest, roost, nectar, lay eggs, burrow or take shelter from a winter storm. What's math got to do with it?

Math in Landscape Design

Without math, we couldn't design these spaces. We use math skills to calculate the size and dimensions of a growing area, the depth of the soil layers, the number of plants that will fit in the landscaped area once they reach mature size, the width of a path to fit young feet exploring the space, the area needed for a bench or a gathering space for students and more.

We prepare to design a schoolyard habitat, and practice math skills, in the process of mapping and inventorying the schoolyard. The new Homes for Wildlife Correlations to the NH Curriculum Frameworks (hot off the press thanks to Nicole Clegg) connects those skills to the process. In addition to the K-12 Mathematics Framework, the HOME correlations cover the frameworks for Science Literacy, the Social Studies Curriculum, the Written and Oral Communication Curriculum and the Reading Curriculum.

The document corresponds to the material in the *Homes for Wildlife* manual, following the schoolyard habitat process as laid out in a sequence of steps. "Mapping the Schoolyard," in chapter 3, addresses math frameworks having to do with measurement and scale. Doing the mapping activities described involves data, statistics and probability, as well as problem solving, reasoning and proof. The Site Inventory Activity Cards, in chapter 4, provide ample opportunity to develop skills in observation while using numbers and operations (Size of the Schoolyard); geometry and measurement (Covered Areas of the Schoolyard Site); and data, statistics and probability (Earthworm Analysis).

No matter what sequence you use or steps you take, creating and using a schoolyard habitat integrates all subject areas, meeting multiple frameworks. For instance, the new science frameworks include "Making Observations and Measurement;" for grade 4 students, this means they will "describe, draw, count and/or measure using available tools." They can accomplish this with the site inventory materials, engaging in a more holistic learning experience and meeting both math and science benchmarks.

© MARILYN WYZGA PHOTO

Using math, students can create a variety of garden shapes, like this triangular bed.

One Small Square of Study

In the winter issue of the WEB Newsletter, I wrote about a study I'd done in seventh grade using a 1-yard square schoolyard plot. I referenced the book series, *One Small Square* by Donald M. Silver, which details this kind of study. It is easy to implement in any schoolyard, since you don't have to do any pre-planning or planting; simply mark out a plot and study what is there.

You can expand the study to any depth you desire. Noted landscape architect Darrel Morrison applied this concept in a grand way when he established a grid as part of a university landscape design; each square in the grid is monitored by a student throughout their freshman year. This kind of long-term study builds a comprehensive body of knowledge about a site, similar to the process taught by the Roger Tory Peterson Institute's "Teaming with Nature" program. Originally known as the Selborne Project, this program was inspired by Gilbert White's book *The Natural History and Antiquities of Selborne*, published in 1789. White observed and painstakingly recorded the flora and fauna local to his parish of Selborne over a period of years, earning him the designation of England's first ecologist. The Teaming with Nature program provides learning experiences for teachers in science, language arts, mathematics and social studies as they investigate an area one square kilometer in size.

Math Practice in the Schoolyard

With an established schoolyard habitat garden or landscape, there are opportunities to count: birds at the feeder, seeds in a seed head, numbers of seedlings shooting up in the spring, species of insects or petals on flowers. There are opportunities to measure: rainfall collected in a rain barrel or bird bath, height and circumference of trees, distance a butterfly will fly between nectar feedings, or weight of bird seed consumed each day by birds at the feeders. There are opportunities to work with percentages, statistics and probability: average rainfall, rate of growth, comparative consumption of different types of seed by local birds, estimating canopy cover, assessing the average height and girth of trees in a forest. Students may use a range of tools from their own hands, arms and feet, to basic rulers and triangles, to densitometers and clinometers, to GPS units, to computer mapping programs.

You can include mathematics in all aspects and all levels of schoolyard investigations. By inches, rows, feet or meters, math can play a major role in the creation and study of a schoolyard habitat. And that counts whether you are exploring what already exists, conceptualizing a new outdoor classroom, or engaging your students in an established schoolyard habitat.

For a copy of *Homes for Wildlife Correlations to the NH Curriculum Frameworks*, contact Marilyn Wyzga at ***marilyn.wyzga@wildlife.nh.gov***, or 603-271-3211.

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Recommended Resources

***Math in the Garden*, from the National Gardening Association**

This engaging curriculum uses a mathematical lens to take children on an education-filled exploration of the garden. Dozens of hands-on activities hone math skills and promote inquiry, language arts and nutrition. All were developed to support mathematics and science standards and were extensively trial-tested by educators and youth leaders nationwide. Grades K-8, 160 pages.

School Grounds Pack – Mathematics,* from *Learning Through Landscapes

Southgate Publishers, 1997, ISBN 1-85741-097-1 (available from Amazon Canada). This series of reproducible activities covers number counting, number patterns, shape and space, measurement and data collecting, all using the features of the school grounds; appropriate for elementary grades. WEB

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the pubic was being put to good use," says Rock, referring to the fact that mission data is often proprietary.

Indeed, says Yves Langevin, the instrument scientist of the OMEGA experiment on Mars Express, "I was very supportive of the use of our data for creating interest in planetary science among high school students and was very pleased with professor Rock's success using the data set. The students managed to grasp the methodology of working with spectral images, using the spectra for identifying, and then characterizing regions of interest on Mars."

Of the project and the opportunity to conduct research under the wings of university scientists, Vaillancourt says, "It helped us, at least to some extent, think like actual scientists – how they approach methods, solve problems."

The high-school students' analysis of Martian spectral data had revealed a wide range of minerals, including some formed by liquid water. To the boys' surprise and delight, an AGU session on the Mars Express mission revealed that the scientists were finding similar results from the data set using similar techniques.

Says Rock, "At one session we heard all this. The boys kept nudging each other as the French scientists explained their findings. It was really wonderful to see them gain confidence and go through this transition from feeling like they'd be laughed at to seeing their findings verified."

Rock stressed to Wright-Eaton and Vaillancourt that, in fact, they had done pioneering work by showing that high school students can both understand the processes of science and become actively involved in them. He adds that this was not lost on the French OMEGA scientists or the stream of NASA scientists who viewed the poster.

"Project SMART is a way of priming the pipeline, if you will, and getting students at an early age interested in science and engineering, which is something NASA will benefit from," Rock notes.

Source: David Sims, Editor and Author of UNH EOS Spheres Newsletter. Reprinted with permission. **www.eos.unh.edu**

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